1910

The West End Association.

REPORT OF

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SOURCE OF SUPPLY.

Collection. All the water which we use originally comes from the clouds in the form of rain. Part of the rainfall immediately flows over the ground into the streams, and is known as "surface run-off". This is of course greatest when the ground is frozen. The remainder, which is the principal source of supply, soaks into the earth as into a sponge and is either sucked up by the roots of trees and other vegetation and re-evaporated into the air, or else it continues to percolate through the soil—later to appear in the form of springs. These feed the streams even during the dry seasons, and for months after any rain has fallen. Thus the ground may be looked upon as a great reservoir storing up water within itself, later to be given out gradually. If the amount of rain falling each month were the same as that falling during each of the other eleven months large artificial storage reservoirs would not be required and it would only be necessary to intercept the stream flow and pipe it direct to the consumer. This is not the case, however. A stream which at one season of the year is so small that it may be crossed on stepping stones is a perfect torrent at other times. But not only does the rainfall vary with the different seasons, it also varies greatly from year to year, and it happens that the rainfall of a "dry year" may be only 60% of that which falls annually under average conditions. These periods of semi-drought often extend over two or three consecutive years and require careful thought on the part of the Engineer who is responsible for the water supply of a great city, that he may have sufficient storage to carry him safely over them. On the other hand there are years and series of years, when the rainfall is excessive, and far beyond that average which can ordinarily be relied upon.

In order to impound all the water which falls in any catchment area it would be necessary to design works of such magnitude that there would be no flow over the waste weir at the end of the period of greatest rainfall; that is to say, that the reservoirs would be just full at the end of the rainiest hour of the rainiest day of the rainiest week of the rainiest year. Therefore it follows that at all other times the reservoirs will be only partially full. The problem is whether it is economically advisable to try to save all the water, or whether there is not a point beyond which additional saving is unduly expensive, and therefore is it not best to design the impounding reservoirs with an eye to average rather than abnormal conditions.

The whole matter resolves itself into a question of dollars. The engineer must be careful not to develop a given watershed to such a degree that additional savings of water will cost more per gallon than the charge for a like quantity when obtained from some other source.

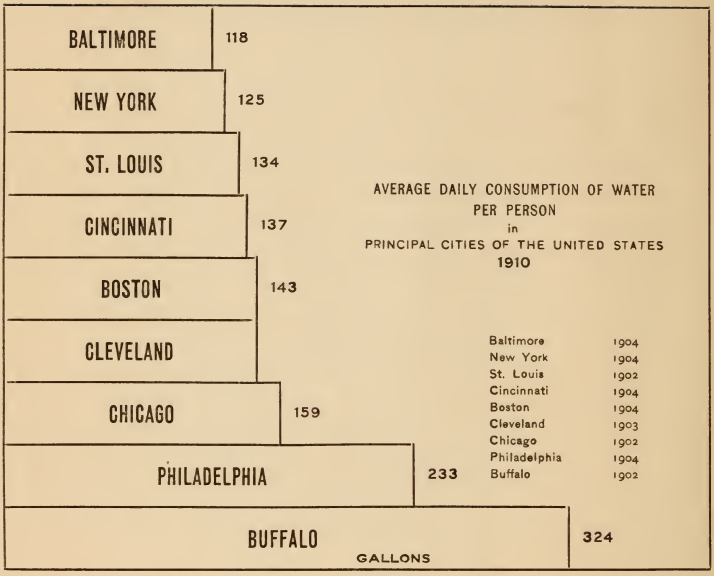
The layman on seeing water run over the spillway of a dam is inclined to say: "If they had only built it a few feet higher they could have saved all that", and he little thinks that the expense of the extra height is not to be measured by the cost of the top courses of masonry (where the dam is only a few feet wide) but by the cost of the *bottom* courses of masonry where the dam may be several hundred feet wide; for dams like high buildings are designed from the top downward that they may properly withstand the weights and strains imposed upon them.

The expense of such structures increases in a way so out of all proportion to their height that instead of placing one huge dam near the mouth of a stream it is always better to locate separate and smaller dams on each of its tributaries, thus creating a number of small reservoirs for temporary storage. This has been done in the Croton watershed and that system now contains no less than ten subsidiary dams. The lakes thus created act as feeders, impounding the water until such time as it may flow into the main storage reservoir to best advantage. The Paterson dam will serve such a purpose, but with its completion the development of the Croton watershed will have reached a point beyond which it will probably not be profitable to carry it. In the opinion of your Committee the construction of this dam is most advisable as it will fully develop that watershed.

DISTRIBUTION.

Use. Of the amount of water brought to New York much is used, some is wasted, and a little is lost. The demands upon the system for water are subject to great fluctuation; thus the amount used in certain months greatly exceeds the average. The amount of water which may be used in a day of maximum consumption is likely to reach 150% of the average; and it is no unusual thing to have a maximum hourly demand for water equal to 175% of the average. That merely means that more water is used in certain seasons of the year than in others; that more water is used on certain days of the week, Monday for instance, than at other times; and that the requirements of the different hours of the day vary greatly. Thus the flow is at a minimum between midnight and 4 A. M. It increases as the activities of the day begin and reaches a maximum in the forenoon when the rate of consumption is greatest. Water is furnished for domestic, commercial and public purposes, but the number of gallons used each day per capita in New York is less than that used in most of our prominent cities. New York is called upon to furnish great quantities of water to a large floating population; the business portion of the city being occupied principally by people whose names do not appear upon the New York census returns as they commute from New Jersey, Staten Island and Long Island. The rapid and regular increase in the population of the city, as shown by successive census returns is a matter which has been taken into account in estimating the quantity of water which will be needed at stated intervals in the future. The most careful estimates now made indicate that the future population of this city will be as follows:

1910	4,625,000
1915	5,250,000
1020	5,875,000
1925	6,500,000
1930	7,125,000


BALTIMORE
118
NEW YORK
125
ST. LOUIS
134
CINCINNATI
137
BOSTON
143
CLEVELAND
CHICAGO
159
PHILADELPHIA
233
BUFFALO
324
GALLONS
AVERAGE DAILY CONSUMPTION OF WATER
PER PERSON
in
PRINCIPAL CITIES OF THE UNITED STATES
1910
Baltimore 1904
New York 1904
St. Louis 1902
Cincinnati 1904
Boston 1904
Cleveland 1903
Chicago 1902
Philadelphia 1904
Buffalo 1902

SKETCH MAP
SHOWING
CROTON AND CATSKILL
WATERSHEDS
1910

Waste. Much of the so-called waste is more correctly extravagant use. Thus water is allowed to run freely during the winter to prevent the pipes from freezing and many people prefer to allow the water to run away rather than go to the expense of repairing their plumbing fixtures.

Loss. Some water is undoubtedly lost through leaky pipes and reservoirs. Practically all of the pipes which were exposed, however, during the construction of the subway appeared to be in good condition and it was evident that the loss from the joints of the pipe system was very small in amount. A break in the distributing system generally makes itself apparent at once, either by appearing through the street surface, or by flooding the surrounding cellars, or by washing away the soil and causing the pavement to sag into the resulting cavity. Many opinions have been advanced concerning the amount of water daily wasted in New York and the estimates have varied from 15% to 50% of the total consumption. Those who estimate the waste at the larger figure have maintained that if this loss can be stopped the present sources of supply would be adequate for many years to come. Some claim that the night flow is the measure of waste, as very little water is being used for domestic and manufacturing purposes during those hours. Many buildings of certain classes in New York are equipped with storage tanks upon the roof, varying anywhere from ten to forty thousand gallons capacity, which are called upon to supply the buildings with water during those periods of the day when the pressure is low in the service mains, due to the large quantities of water being used. These tanks are filled during the hours of the night when the pressure is again normal and that in our opinion accounts for a large proportion of the night flow. Much water is also used at night all the year around by power plants, and during the winter time for steam heating and other purposes.

ADDITIONAL SUPPLY.

The most reliable figures, which make preventible waste under 15%, show that were it possible to stop all waste, the resultant saving in water would not be sufficient to enable the city to get along with the supply which the Croton watershed is safely able to furnish. The city

authorities have realized this and have made investigations concerning the best sources of additional supply. Interstate water is not available and the city has therefore been obliged to eliminate Ten Mile River and the Delaware River from consideration. With the passage of the Smith Bill the city was forbidden to develop the watersheds east of the Hudson river, including those in Dutchess County. The Catskills were next looked to as the possible source of supply and their watersheds are now being developed to meet the demands which the city is already making for additional water. In the opinion of your Committee this work has not been undertaken any too soon, and its progress is highly satisfactory.

Some not familiar with the situation have criticised the Board of Water Supply under the impression that they are developing a watershed on the west side of the river before satisfying themselves that it is possible to conduct the water across the Hudson to New York. There has never been any question as to the possibility of getting the water across the Hudson. The only problem confronting the engineers is which of the four possible methods will be the most satisfactory; for it is possible to employ (1) a bridge to carry the pipes (2) or lay pipes on the bed of the river (3) or construct either a shallow tunnel (4) or a deep tunnel through solid rock. The deep tunnel would not be hampered in its construction by many of the difficulties connected with sub-aqueous work.

The cost of condemnation proceedings in the Catskills has been very severely criticised but not being an engineering matter is respectfully referred to the Committee on Legislation, Law and Schools, as the remedy for such conditions is by means of a legislative enactment. The Board of Water Supply is not in any way connected with the work of condemnation.

ACQUEDUCT UNDER NEW YORK.

The plan for conducting the water from the Hill View reservoir at the northern limit of the city and distributing it to the service pipes has received our careful consideration. The problem to be solved by the engineers of the Board of Water Supply is one of moving large quantities of water in bulk (500,000,000 gallons daily) from the reservoir to

the various distributing points, where the Department of Water Supply, an entirely different Bureau, takes charge of it and delivers it to the consumers through the street pipes. In the Report of the Board of Water Supply of October 9, 1905, it was tentatively proposed to conduct part of the 500,000,000 gallons, namely 120,000,000 gallons, daily to Brooklyn by means of a pipe line. The Board states "It is possible that studies made more in detail will indicate some modification of this line to be advisable, and the precise form, dimensions and locations best adapted for the proposed terminal reservoirs of the acqueduct system in Brooklyn and on Staten Island, remain as subjects for further study. The main distributing lines from Hill View reservoir to the Boroughs of Manhattan, Queens and the Bronx are matters for later consideration". It is thus seen that the treatment of the remaining 380,000,000 gallons daily had not at that time been decided upon. Later it was found advisable to abandon the tentative plan for the pipe line and conduct all the water into the city through a large tunnel which was to be constructed at suitable depth in the rock formation under the city. This can in no way be called a "change of plan," because at the time of the Report mentioned the Board had not reached any definite decision as to the best way of conducting this water, and the present plan is the result of complete examinations and investigations made since that date. The only change is the abandonment of the tentative plan to carry 120,000,000 gallons daily by a pipe line to Brooklyn and Richmond. This change is advisable for a number of reasons.

The cost of the deep rock tunnel will be much less than that of any system of piping. The openings to the tunnel will be upon property owned by the city. The work of tunneling will be conducted at considerable depths without that inconvenience to business and transportation which results whenever the streets of the city are disturbed for the purpose of laying pipes. A rock tunnel of this character is one of the most permanent structures that engineers can build. It is at once practical, safe, economical as to first cost, and maintenance charges will be at a minimum. The disadvantages attending the alternative plan of bringing water from the reservoir to the distributing points in a considerable number of large iron or steel pipes (72" pipes would be required) are very great. The cost of the work would be excessive as the

streets of New York are already so filled with pipes and subsurface structures that placing these mains would be costly. The incidental damage done to business interests in those streets which would be ripped up for the purpose would be exceedingly great. The loss to merchants and property owners on 42nd Street during the construction of the present subway tunnels indicates what might be expected. It has been proposed to "kill two birds with one stone" and place these mains in excavations built for future subways, that is, construct the subway at the same time the water mains are installed. We all know the damage that results when a water main, even as small as 24" in diameter is broken. Should a leak occur in one of these 72" pipe the damage which would be wrought is incalculable and it is practically certain that all persons riding at that time in the subway would be drowned like rats in a trap.

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